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Huston

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[54] **AIR HEATER WITH AUTOMATIC SEALING**

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[73] Assignee: **The Babcock & Wilcox Company**, New Orleans, La.

[21] Appl. No.: **693,189**

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Related U.S. Application Data

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[51] **Int. Cl.**^{5} **F28D 17/04**

[52] **U.S. Cl.** **165/4**; 165/9

[58] **Field of Search** 165/4, 9

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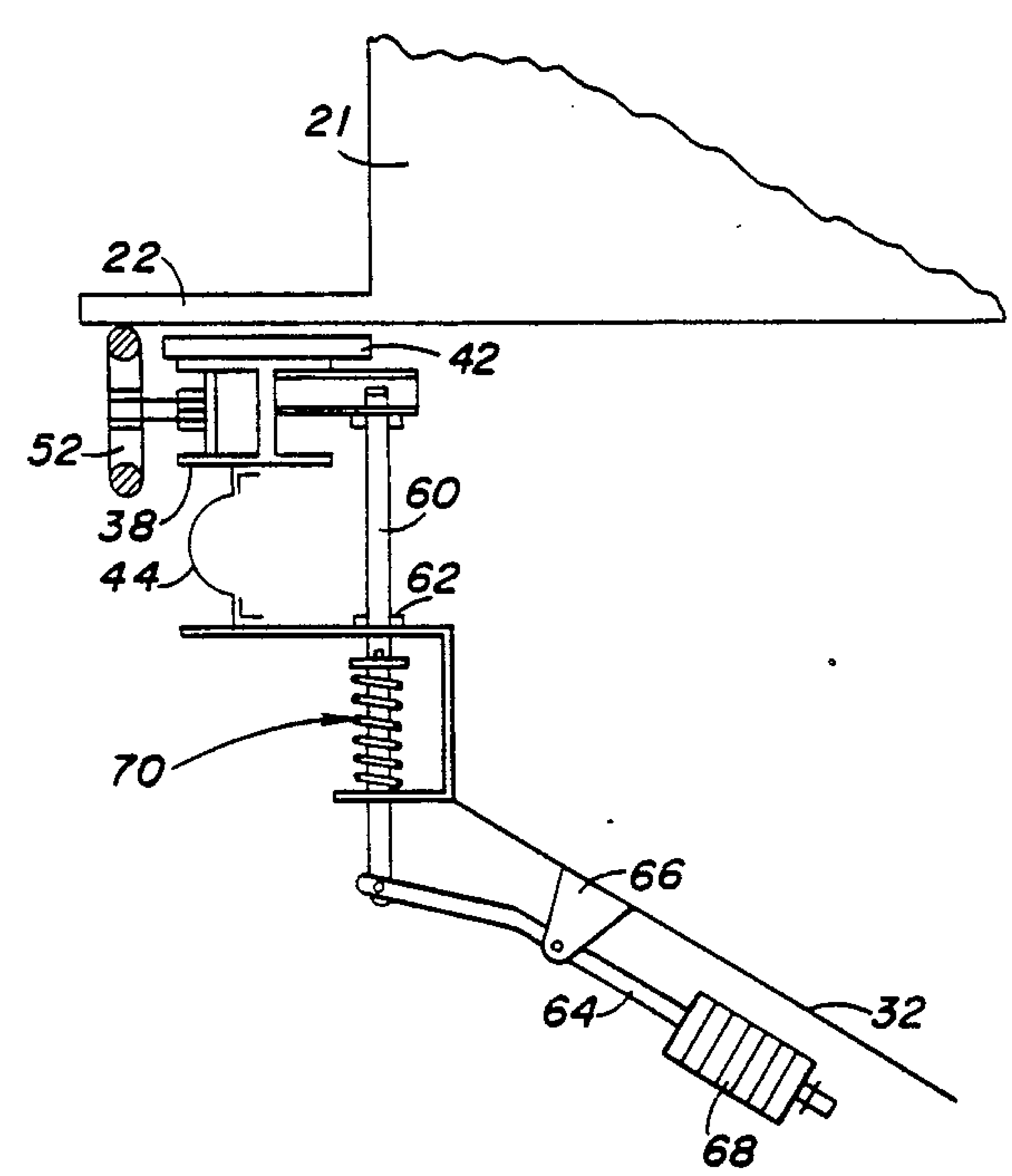
Primary Examiner—Albert W. Davis, Jr.
Attorney, Agent, or Firm—Vytas R. Matas; Robert J. Edwards; Eric Marich

[57] **ABSTRACT**

A sealing arrangement for a regenerative air heater having a stator with a peripheral flange and hot and cold end hoods mounted for rotation over respective opposite surfaces of the stator, includes a seal frame which is connected to the cold end hood over an expansion joint assembly. A plurality of cast iron seal shoes are connected to the frame and positioned at selected gaps from the stator flange. A wheel rotatably mounted to the frame near each seal shoe rolls against the stator flange to maintain the selected gap while a counter weight on a lever acts to urge the seal shoes toward the flange. The arrangement is automatic in its maintenance of the selected gap.

6 Claims, 7 Drawing Sheets



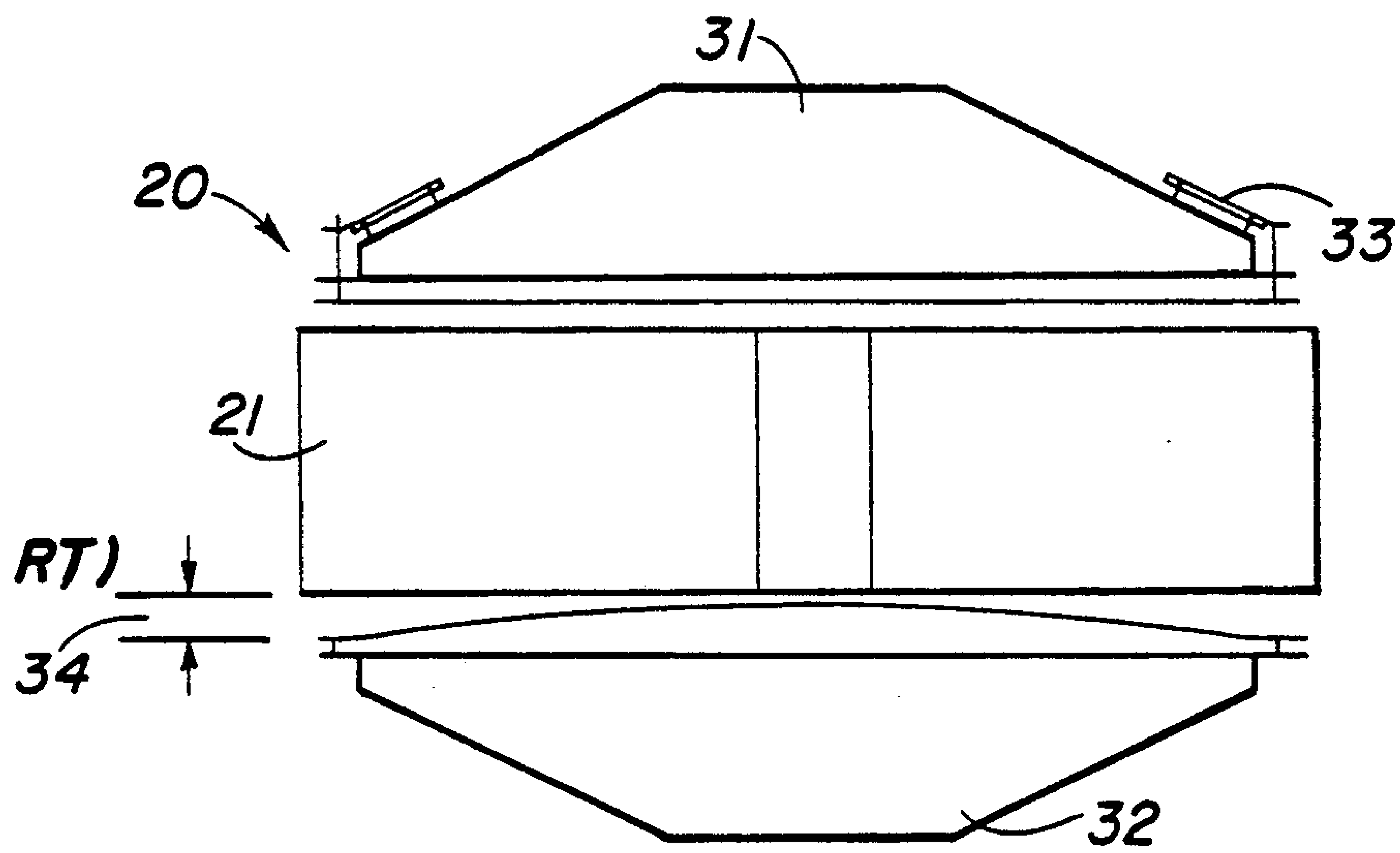


FIG. 1
(PRIOR ART)

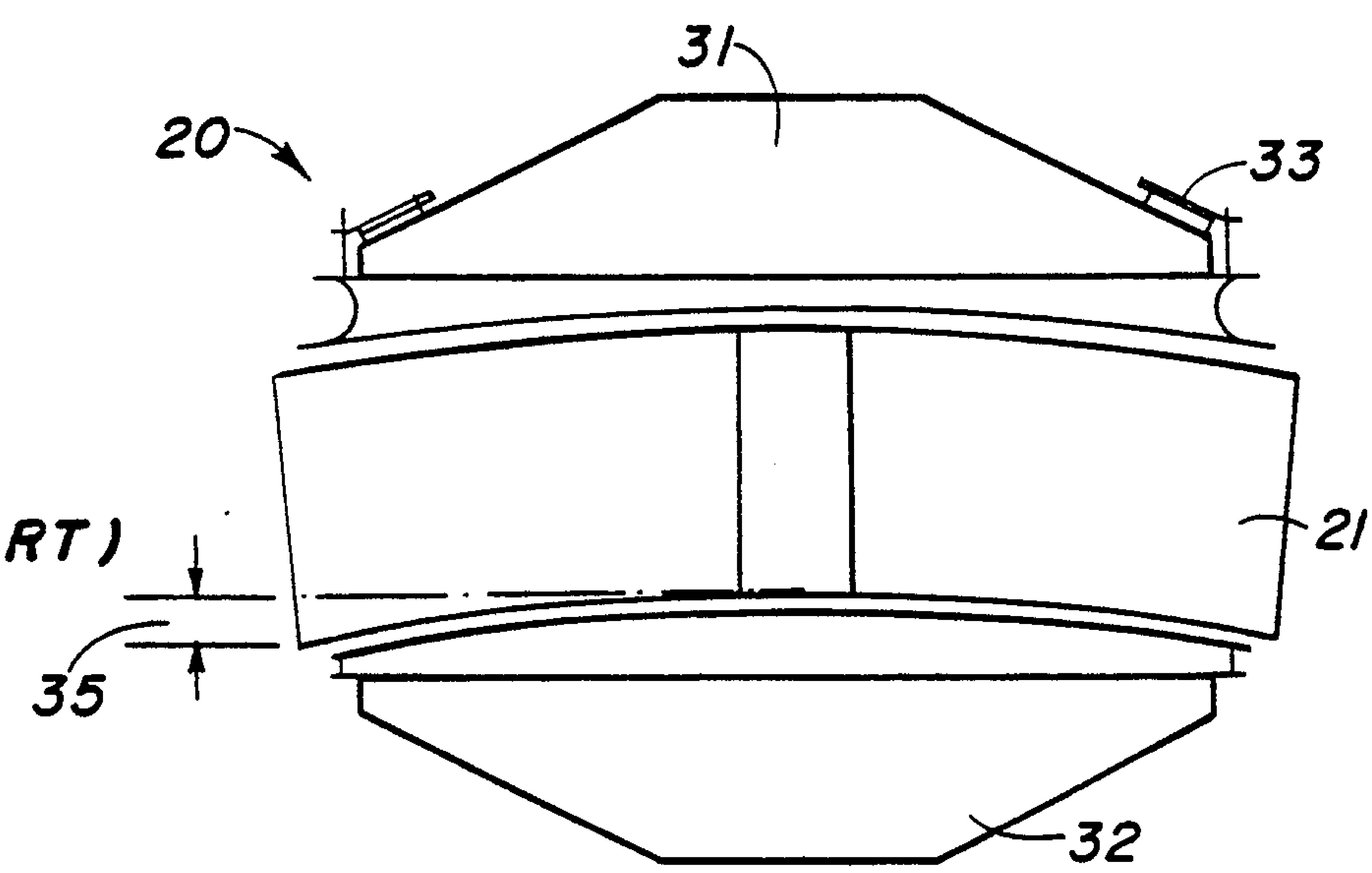


FIG. 2
(PRIOR ART)

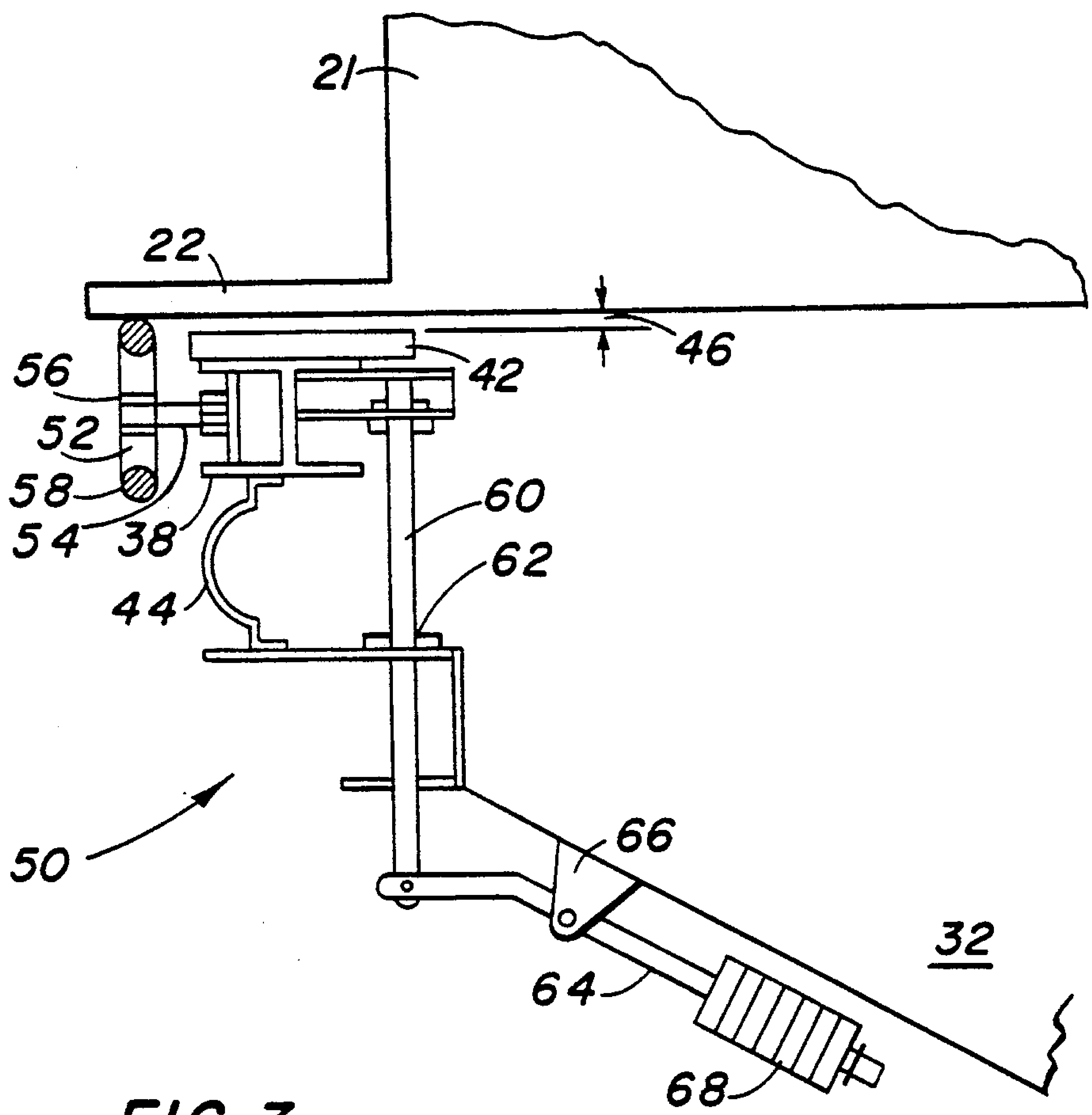


FIG. 3

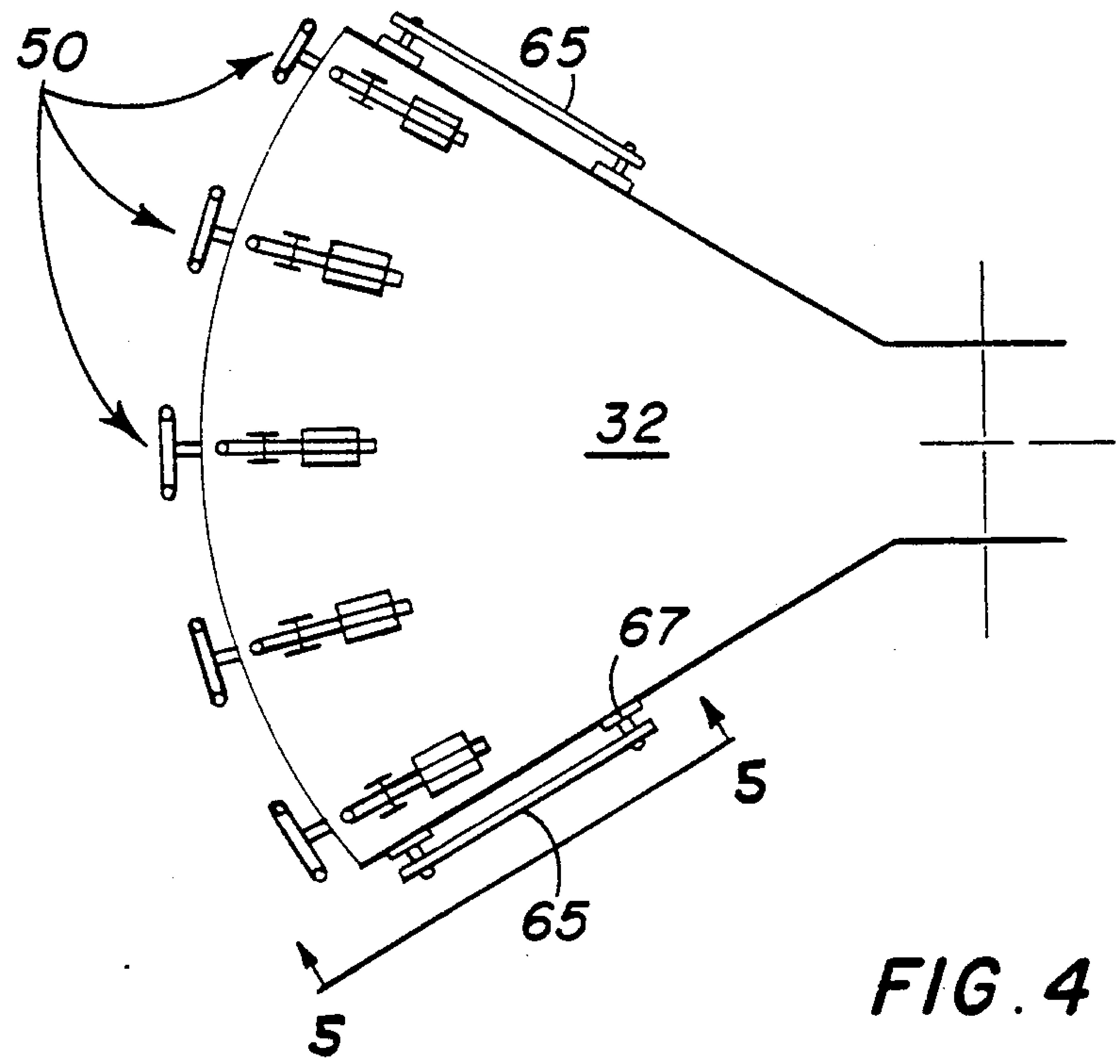
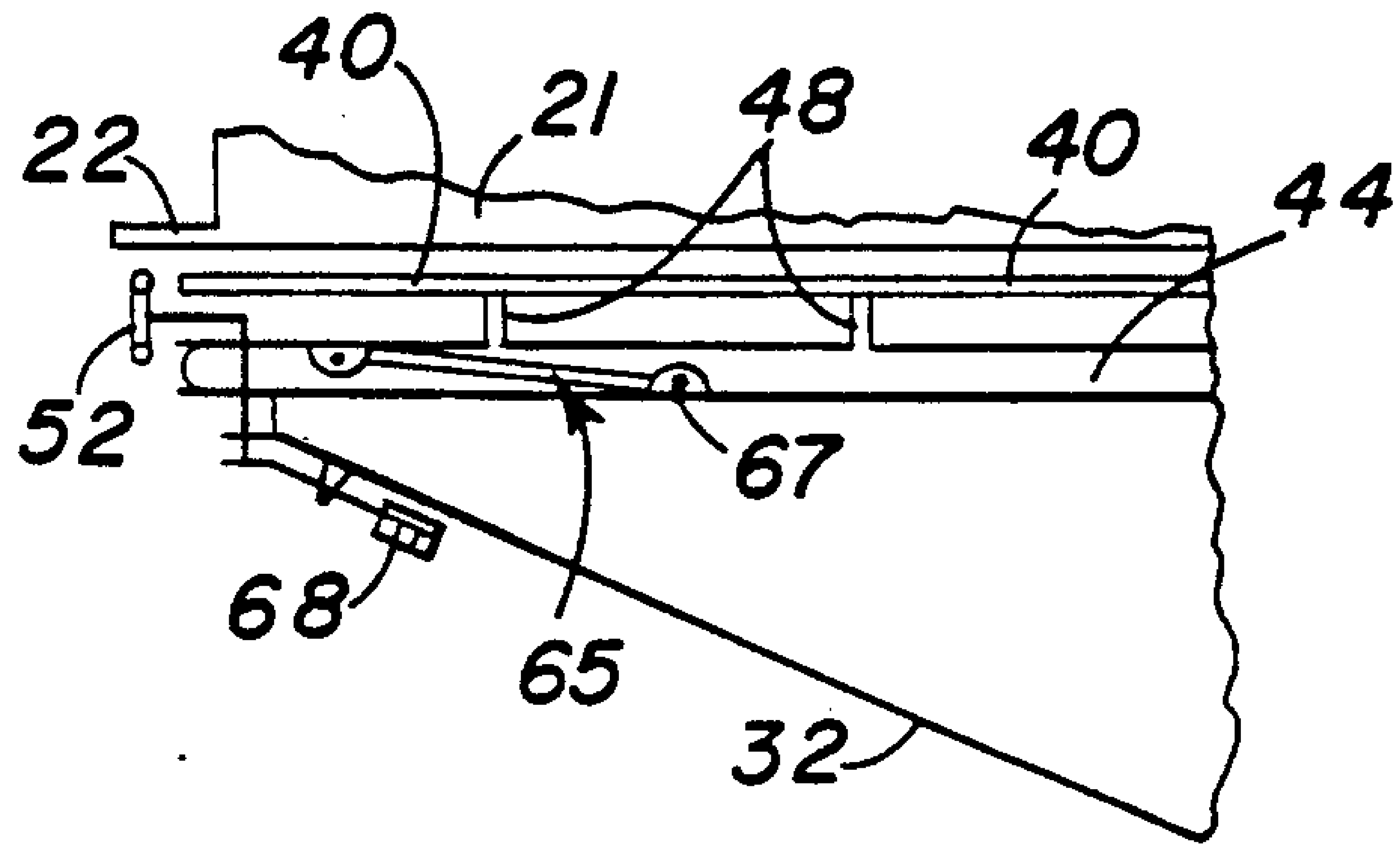


FIG. 4

FIG. 5



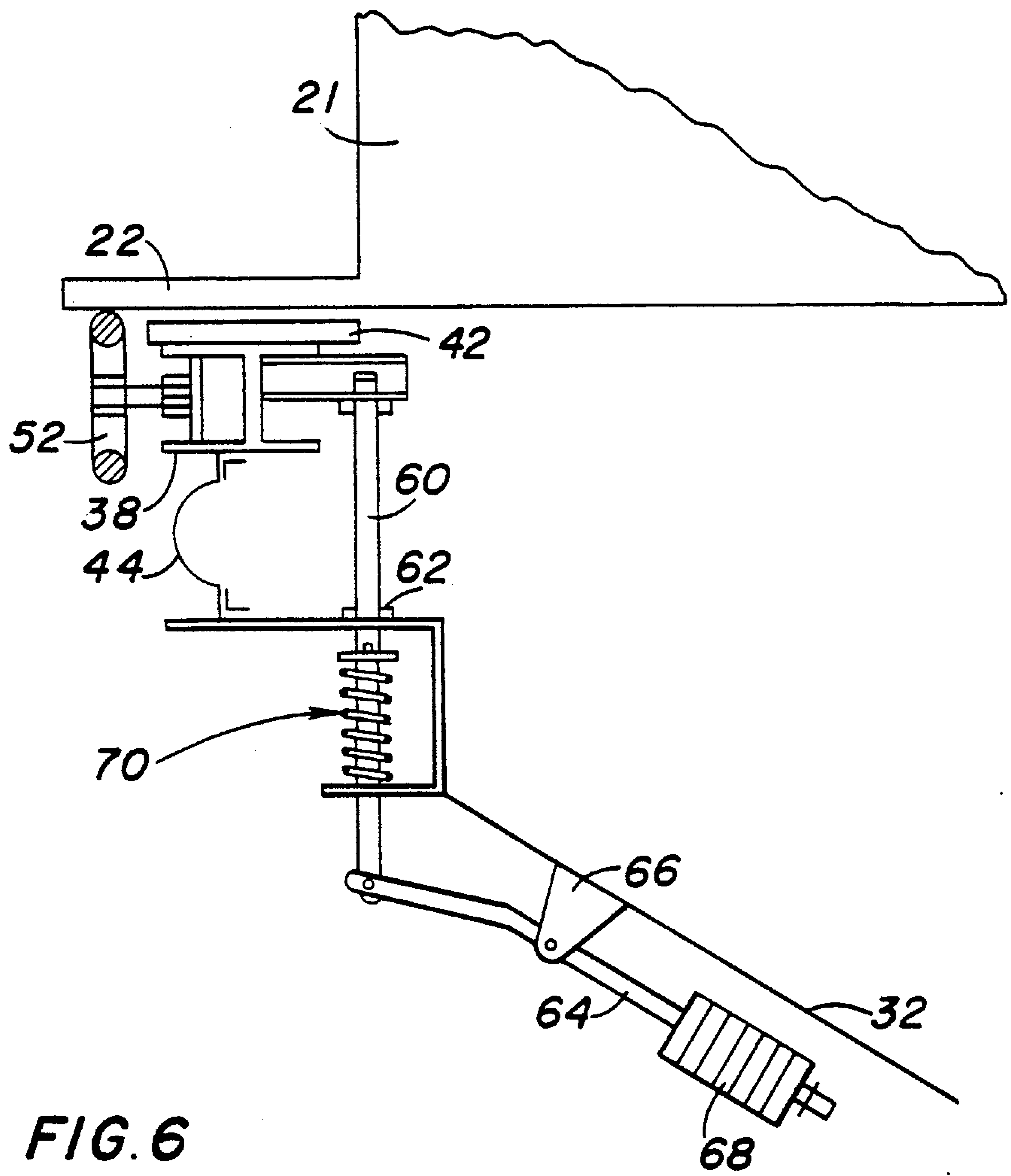


FIG. 6

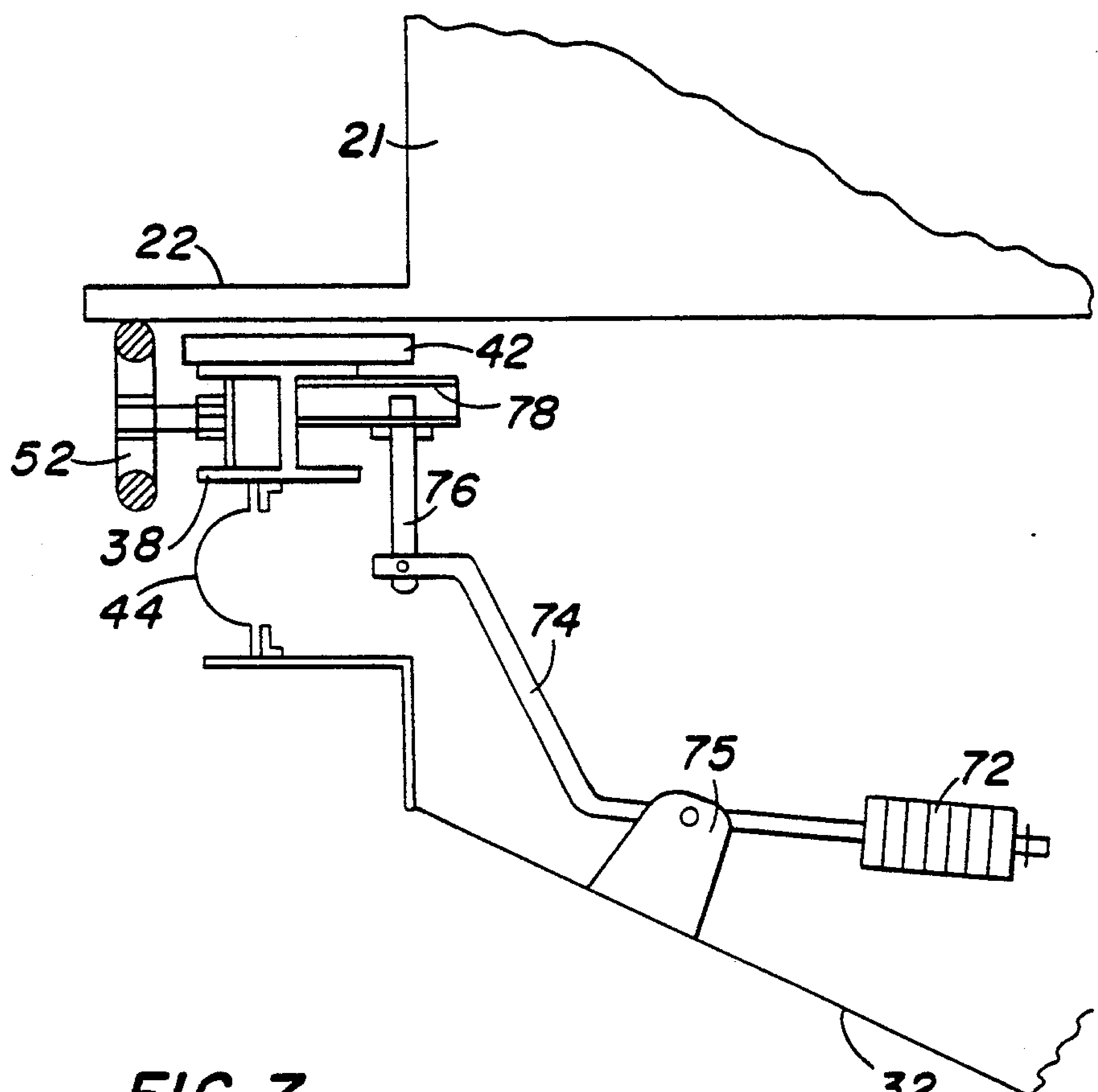


FIG. 7

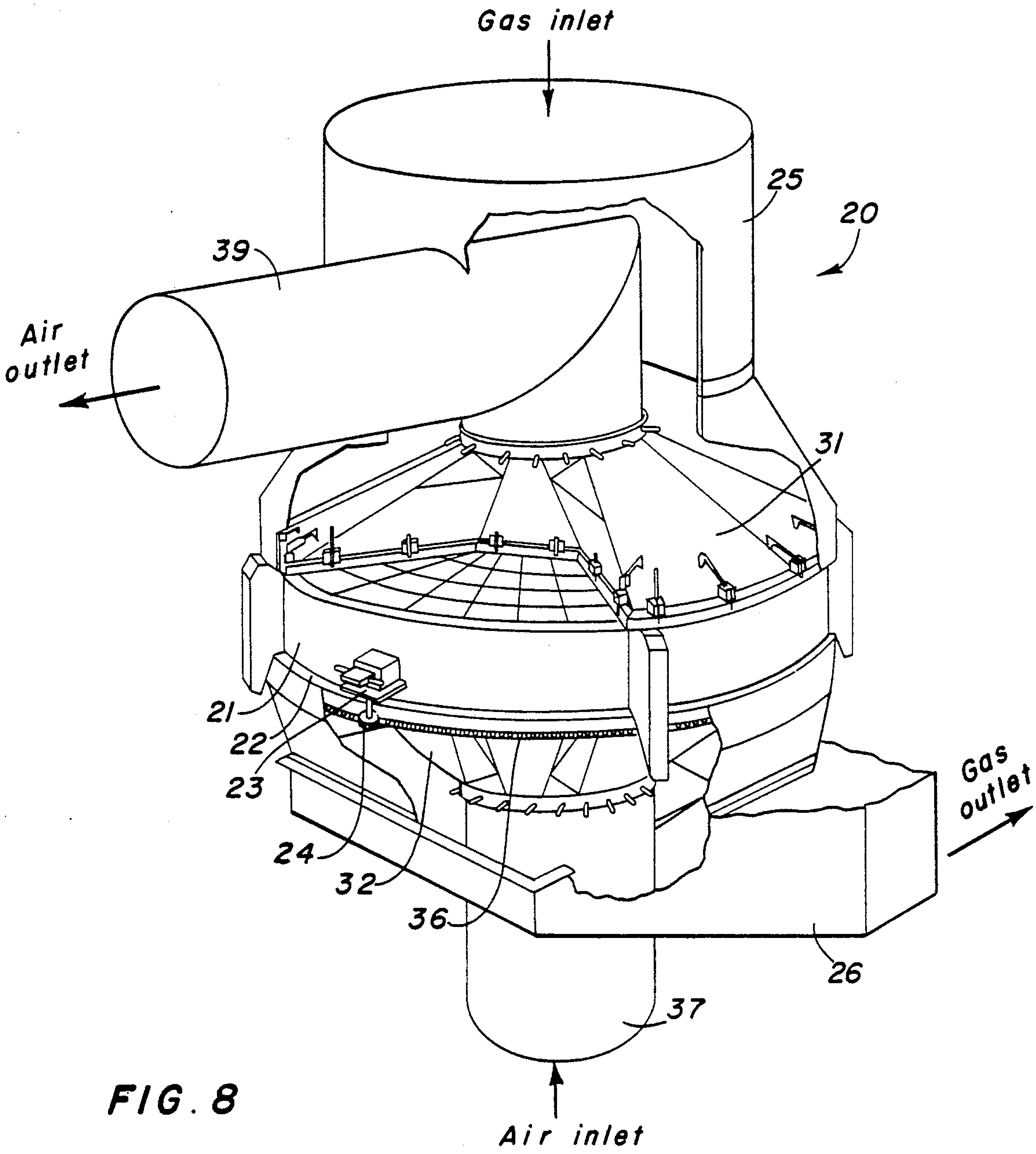

Gas inlet
25
20
39
Air outlet
31
21
22
23
24
32
36
Gas outlet
26
37
Air inlet

FIG. 8

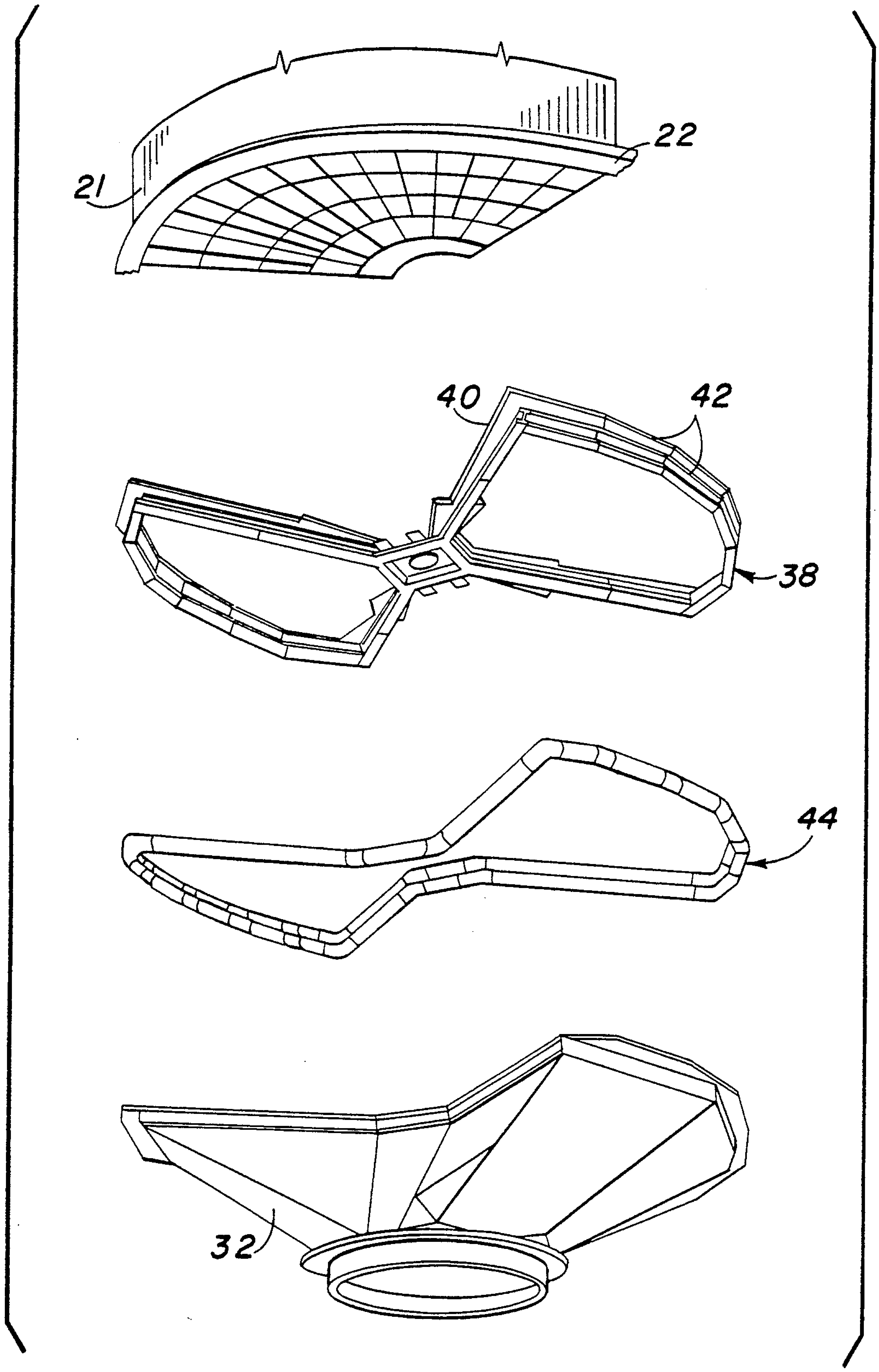


FIG. 9

AIR HEATER WITH AUTOMATIC SEALING

This is a division of application Ser. No. 602,440, filed Oct. 22, 1990.

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates in general to rotary regenerative air heaters for transferring waste heat from boiler flue gas to combustion air and, in particular, to a new and useful automatic mechanical cold end sealing system connected to air seals of a duct hood frame in the regenerative air heater.

In one type of rotary regenerative air heater, a cylindrical heat exchange mass and a containment structure, called the stator, are positioned stationary between the inlets and outlets of the air and gas ducts. The stator is a radially compartmented steel shell packed with a multiplicity of plates, arranged to provide an axial passage therethrough, such that the gas and air flow in an axial direction through the cylindrical heat exchange mass. The plates embody shapes, materials and thicknesses designed to provide optimum heat transfer, low pressure drop, resistance to corrosion, and ease of cleaning.

Air ducts at each axial end of the stator include air duct hoods, co-axially aligned with the cylindrical heat exchange mass, which are secured to a central drive shaft for co-axial rotation in relation to the cylindrical heat exchange mass. Each of the air duct hoods comprises a respective central flow inlet or outlet passage centrally mounted between, and in fluid communication with, two diametrically opposite hood segments or sectors for the passage of air to or from the heating mass. The hood segments of each of the air duct hoods are generally pie-shaped and circumferentially spaced from each other.

The gas ducts are arranged stationary, also at the opposite ends of the stator, and surround the rotating air duct hoods.

The air duct hoods, at upper and lower ends of the heat exchange mass, rotate synchronously so that alternate radial sectors of the mass of plates are alternately exposed to a hot flue gas stream and then cooled by a combustion air stream thereby effecting a regenerative heating and cooling cycle.

Sealing between the stationary and rotating components is achieved by articulated seal frames which are spring mounted to the rotating air duct hoods. As the stator expands or contracts, the frames adapted to the stator's periphery in order to maintain an effective seal at various boiler loads. The seal frame, which extends along the peripheries of the hood segments adjacent the heat exchange mass, carries a sealing strip. The sealing strip is resiliently urged in close proximity to cylindrical and radial end surfaces of the stator. During rotation of the air duct hood, the sealing strip slides along the end surfaces in sealing relationship with the stator.

An expansion joint is connected between the seal frame and the air duct hood to accommodate relative thermal displacement.

U.S. Pat. No. 4,669,531 discloses such a rotary regenerative air heater.

Apparatebau Rothemuhle of Germany manufactures this type of regenerative air heater.

In the Rothmuhle type regenerative air heater, sealing at the hood-stator interface is maintained by use of replaceable cast iron seal shoes mounted on a structural steel seal frame which is connected to the hood by a single fold expansion joint. The seal frame is supported on the hood by a number of spring bolt assemblies at the hood perimeter. Radial portions of the seal frame are equipped with a number of hinged articulation joints which enable the seal frame to follow the curvature of the stator as it deforms during operation.

Rothmuhle type air heaters employ thermally activated devices on the hot hoods to automatically lower seal shoes as the stator distorts, thereby maintaining minimum seal gaps. The thermal devices are not used on cold end hoods because temperatures are too low for them to function effectively. Therefore, seal gaps on the cold hood are preset away from the stator in the cold condition by the amount of expected maximum stator distortion which occurs at full load.

FIG. **1** illustrates the cold condition for a regenerative air heater generally designated **20**, which comprises a stator **21** which has not yet been deformed due to thermal stresses, a hot hood **31** and an opposite cold hood **32**. The known thermal activated devices **33** are shown in place on the hot hood. FIG. **1** also illustrates the substantial preset gap **34** which occurs between the lower surface of the stator **21** and the upper sealing surface of the cold hood **32**, in the cold condition.

FIG. **2** corresponds to FIG. **1** but illustrates the heater **20** in its hot condition. In this condition, the stator **21** has been thermally distorted by a stator distortion amount **35** which serves to move the lower surface of the stator **21** into closer association with the upper sealing surface of cold hood **32**.

Rothemuhle has also developed an automatic cold end seal system which utilizes an electro-mechanical device to maintain a programmable seal gap setting throughout the boiler's normal operating range to reduce air heater leakage. Inductive sensors placed in a flange of the air heater sense seal gap magnitudes as the hoods rotate. Signals are sent to a control computer where they are evaluated and compared to a preprogrammed gap. Adjustments are made by a motor driven ramp which activates a contact lever arm on the rim of the cold hood, to raise or lower the seal frame and bring the gap into tolerance. This device has the disadvantage of being complex. It also relies on the use of sensors in a hostile environment. Failure of any one of the critical components would also lead to failure of the seal.

Other solutions for adjusting the seal gap in a regenerative heater have also been proposed over the years.

U.S. Pat. No. 3,232,335 discloses pneumatic, mechanical and magnetic systems for sensing and thereafter compensating for variations in the seal gap. U.S. Pat. No. 3,246,686 discloses an arrangement which utilizes a plurality of individually rolling elements mounted independently of each other and connected to a floating sealing plate. The wheels roll against an annular flange of a rotor, and vary the force applied to the floating sealing plate as a function of the rolling action. U.S. Pat. No. 3,344,849 utilizes a spring plus counter weight arrangement for varying the force applied to a seal plate in a regenerative heater. All of these proposals suffer from complexity and sensitivity to mechanical, pneumatic or electrical failure.

SUMMARY OF THE INVENTION

The present invention comprises a completely mechanical and automatic air heater cold end sealing system. The system functions to maintain a preset hood seal shoe to stator face gap during all conditions of air heater operation. The seal shoes are at all times kept in close proximity to a stator flange by force applied to the seal frame via counter weight devices. Wheels fitted to the seal frame, through which a portion of the counter weight force is transmitted, roll round the stator flange perimeter thereby maintaining a constant seal gap.

Accordingly, an object of the present invention is to provide a sealing arrangement for a regenerative air heater having a stator with a peripheral flange, and hot and cold end hoods mounted for rotation over respective opposite surfaces of the stator, the arrangement comprising a seal frame for extending adjacent at least part of the stator flange, an expansion joint assembly connected between the cold and hood and the seal frame for movably mounting the frame to the cold end hood, at least one seal shoe connected to the frame and positioned at a selected gap from the stator flange, at least one wheel mounted for rotation to the frame near the shoe, the wheel rolling against the flange for maintaining the selected gap, and biasing means connected between the cold end hood and the frame for biasing the shoe toward the flange in a direction tending to reduce the size of the selected gap.

A further object of the present invention is to provide a sealing arrangement which is simple in design, rugged in construction and economical to manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a schematic and exaggerated side elevational view of a conventional regenerative air heater in its cold condition;

FIG. **2** is a view similar to FIG. **1** of the heater in its hot condition;

FIG. **3** is a side elevational view of a first embodiment of the invention; **4** is a partial, bottom plan view of the cold end hood showing the sealing arrangement of the invention installed;

FIG. **5** is a side elevational view taken in the direction of arrows **5**—**5** of FIG. **4**;

FIG. **6** is a view similar to FIG. **3** of a second embodiment of the invention;

FIG. **7** is a view similar to FIG. **3** of a third embodiment of the invention;

FIG. **8** is a side perspective view, with portions cut away, of a regenerative heater with which the present invention can be utilized; and

FIG. **9** is a perspective exploded view of the cold end hood with associated parts, with which the present invention can be utilized.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, the invention embodied therein is utilized in a regenerative air heater shown in FIGS. **8** and **9**. As illustrated in FIG. **8**, the heater generally designated **20** comprises a fixed stator **21** having upper and lower surfaces for respectively receiving and discharging hot exhaust gas supplied by a hot gas inlet housing **25** and discharged by a cold gas outlet housing **26**.

Upper hot end hood **31** and lower cold end hood **32** are connected to each other by an internal shaft (not shown) and, together, rotate over the respective opposite surfaces of the stator for supplying air to be heated through the stator. Rotation of the hoods is produced by a drive unit **23** mounted to the stator. Drive unit **23** rotates a pinion **24** which is meshed with a ring gear **36** fixed at the periphery of the cold end hood **32**.

Air is provided to the cold end hood through an inlet duct **37** and is collected from the hot end hood **31** by an air outlet duct **39**.

As best shown in FIG. **9**, cold end hood **32** carries a seal frame **38** that extends along at least part of a peripheral flange **22** of the stator **21**. An expansion joint assembly **44** connects the frame **38** to the hood **32** for movably mounting the frame to the hood.

The seal joint **38** carries a plurality of cast iron seal shoes **40** and **42**. Seal shoes **40** extends radially across the gas exchange surface of the stator while peripheral seal shoes **42** extend adjacent, along and at a slight gap from the peripheral flange **22** of the stator **21**.

Referring now to FIG. **3**, a first embodiment of the present invention is a sealing arrangement generally designated **50** for the heater which is designed to mechanically and automatically maintain a selected gap **46** between the seal shoe **42** mounted on the seal frame **38**, and the peripheral flange **22** of the stator **21**.

To this end, a wheel **52** is mounted for rotation at a bearing **56** on a shaft **54** which is fixed to frame **38**. Wheel **52** has a tire **58** with rolls against the under surface of flange **22** for maintaining a minimum size for gap **46**.

To keep the seal shoe **42** from moving away from the flange **22**, the invention also includes biasing means in the form of a bolt **60** fixed at this upper end to the frame **38**, and slidably mounted through an opening **62** in a periphery of the cold end hood **32**. Upward pressure is exerted on bolt **60** by a lever **64** pivotally mounted at a pivot bracket **66** to the outer surface of hood **32**, and a counter weight **68**.

Advantageously, wheel bearing **56** is sealed and lubricated to allow unattended operation for periods of 18 months in hot (400° F.) dusty flue gas environments. Tires **58** are replaceable and advantageously made of high temperature solid elastomeric material.

As best shown in FIGS. **4** and **5**, proportional seal gap maintenance is achieved for the radial leg seal shoes **40** by a radial arm **65** which is pivotally mounted at one end to the outer-most radial seal shoe **40**, and at an opposite end to a near mid-radial position **67** of the cold and hood **32**. Hinges **48** interconnect the radial seal shoes **40**, for transmitting forces from one seal shoe to the next, to maintain a proportional seal gap over the surface of the stator. As shown in FIG. **4**, a plurality of the sealing arrangements **50** may be provided.

FIG. **6** shows a second embodiment of the invention where, like in the remaining figures, the same reference numerals are utilized to designate the same or similar parts.

In FIG. **6**, a spring **70** is engaged between the bolt **60** and the hood **32** for increasing the biasing force of the counter weight **68** in a direction to close the gap between the seal shoe **42** and the flange **22**. Here again, the biasing force is counteracted by the wheel **52** rolling against the flange **22**.

FIG. **7** shows a third embodiment of the invention where the biasing means are mounted entirely internally of the hood **32** to avoid the small amount of gas leakage that would occur in the embodiments of FIGS. **3** and **6**, through the opening **62** for slidably receiving the bolt **60**.

In the embodiment of FIG. **7**, counter weight **72** is connected to an inner end of lever **74** which is pivotally mounted at **75** to the inner surface of hood **32**. The outer end of lever **74** is pivotally connected to a bolt **76** which, like in the embodiments of FIGS. **3** and **6**, has an upper end fixed to a bracket **78**, which in turn is fixed to frame **38**. In this way, the upper biasing force on seal shoe **42** is established with a mechanical automatic mechanism that is internal of the hood **32**.

What is claimed is:

1. A sealing arrangement for a regenerative air heater having a stator with a peripheral flange, and hot and cold end hoods mounted for rotation over respective opposite surfaces of the stator, the arrangement comprising:

a seal frame for extending adjacent at least part of the stator flange;

an expansion joint assembly connected between the cold end hood and the seal frame for movably mounting the seal frame to the cold end hood;

at least one seal shoe connected to the frame and positioned at a selected gap from the stator flange;

at least one wheel mounted for rotation to the frame and near the shoe, the wheel rolling along the flange for maintaining the selected gap; and

biasing means connected between the cold end hood and the frame for urging the seal shoe toward the stator flange for reducing a size of the selected gap against the influence of the wheel for maintaining the selected gap, said biasing means including a lever pivotally mounted to an exterior surface of the cold end hood, a weight at one end of the lever, a bolt slidably mounted through an aperture in the cold end hood at an opposite end of the lever, connected between the lever and the frame, and a spring engaged between the bolt and the cold end hood for increasing the biasing force urging the seal shoe toward the stator flange.

2. An arrangement according to claim **1**, wherein the at least one seal shoe comprises a peripheral seal shoe, at least one radial seal shoe operatively connected to the peripheral seal shoe and connected to the frame for extending radially along one of the opposite surfaces of the stator, and radial arm means connected between the radial seal shoe and the cold end hood for maintaining a proportional gap between the radial seal shoe and the surface of the stator, which is proportional to the selected gap between the peripheral seal shoe and the stator flange.

3. An arrangement according to claim **2**, wherein said radial arm means comprises a radial arm having one end pivotally connected to the radial seal shoe and an opposite arm pivotally connected to the cold end hood.

4. An arrangement according to claim **3**, wherein the opposite end of the radial arm is pivotally connected to the cold end hood near a radial midpoint of the cold end hood.

5. An arrangement according to claim **1**, including a plurality of seal shoes connected to the seal frame, a plurality of wheels mounted for rotation to the frame, one wheel being mounted near each respective seal shoe, each wheel rolling against the stator flange for maintaining a selected gap between each seal shoe and the stator flange, and separate biasing means connected to the cold end hood for each seal shoe, said seal shoes being circumferentially spaced along the flange.

6. An arrangement according to claim **1**, including a shaft connected to the frame, said wheel being rotatably mounted to the shaft on a sealed lubricated bearing, the wheel including a tire for rolling along the stator flange.

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